IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants:	Ishida et al.
Appl. No.:	09/646,849
Filed:	October 17, 2000
Title:	APPARATUS AND METHOD FOR JOINT MECHANISM, JOINT APPARATUS, AND ROBOT DEVICE AND CONTROL METHOD THEREOF
Art Unit:	2837
Examiner:	M. Fletcher
Docket No.:	113298-002

Commissioner for Patents
Washington, DC 20231

APPELLANTS' APPEAL BRIEF

Sir:

Appellants submit this Appeal Brief in support of the Notice of Appeal filed on January 29, 2004. This Appeal is taken from the Final Rejection dated July 30, 2003.

I. REAL PARTY IN INTEREST

The real party in interest for the above-identified patent application on appeal is Sony Corporation by virtue of an Assignment dated October 20, 2000 and recorded at the United States Patent and Trademark Office at reel no. 011191, frame no. 0337.

II. RELATED APPEALS AND INTERFERENCES

Appellants do not believe there are any known appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision with respect to the above-identified Appeal.

III. STATUS OF THE CLAIMS

Claims 1, 3, 4, 6, 8, 9 and 11-30 are pending in this Application. A copy of the appealed Claims 1, 3, 4, 6, 8, 9 and 11-30 are attached in the Appendix. Claims 1, 3, 4, 6, 8, 9 and 11-30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,807,153 ("*Onaga et al.*") in view of U.S. Patent No. 5,245,263 ("*Tsai et al.*"), U.S. Patent No. 6,222,338 ("*Villaret*") and U.S. Patent No. 6,064,167 ("*Takenaka et al.*").

IV. STATUS OF THE AMENDMENTS

A Response after the Final Rejection was filed on October 30, 2003. The Response was not entered by the Examiner.

V. SUMMARY OF THE INVENTION

The present invention is directed to a robot device, joint mechanism and joint apparatus and method for controlling the same.

Robots are used to perform various functions in several different industrial applications. Specifically, walking robots are used to perform some of these functions. Walking robots typically include two legs which have connecting pairs of leg units. The leg units connect to a belly unit through a thigh joint mechanism. (Specification, page 1, lines 10-15). The two-legged walking robots include an actuator or servo motor, which causes the different leg units and joints of the robot to move according to a desired function being performed by the robot. Typically, each motor of each joint mechanism can be individually driven and controlled to cause the robot to walk. (Specification, page 1, lines 16-22). To accomplish a walking function, the robots include various sensors such as a pressure sensor, a tilt angle sensor, an acceleration sensor, a

microswitch and similar components provided at the joints of the robot. (Specification, page 2, lines 1-9). These components enable a robot to walk on level or unlevel surfaces. The sensors enable a user to detect the movement and position of the individual leg units on the robot to control the walking of the robot. The sensors however are complex and add to the total weight of the entire robot. Additionally, wiring is required to electrically connect the sensors with a controller, which controls the movement of the robot. (Specification, page 2, lines 10-18). The complex sensors and complicated wiring are necessary to control the movement of the leg joints of the robot. Also, the sensors require software in the controller to control the walking movements of the robot. (Specification, page 2, lines 15-18). This adds complexity to the overall design of the robot.

A conventional two-legged walking robot includes a main control unit which controls the operations of the entire robot. The main control unit is then connected to each motor which is located at the joints of the leg units. (Specification, page 2, lines 19-24). Typically, on a two-legged walking robot three rotation drive cables (u phase, b phase and w phase), four rotation position sensor cables (a phase, b phase and z phase) and one abs position serial signal cable are required to control the movement of the robot joint. Thus a total of seven cables are required which causes the robot mechanisms to be more complex and complicated due to the large number of wires in the robot. (Specification, pages 3, lines 1-7). The complex wiring scheme and controls necessary to control the conventional two-legged robot cause problems because the overall weight of the robot increases due to the extensive cables and sensors needed to control the robot, and the complexity in number and large number of wires inhibits the mobility of the robot. Additionally, the extra wiring and sensors make the robot more susceptible to malfunction such as a wire breaking.

Therefore, the present invention is directed to solving the issues related to conventional walking robots by providing the apparatus and method for controlling the joint mechanisms of the robot using less wiring and sensors and a more simplified control method.

In one embodiment of the present invention, a joint mechanism control device includes electric current detector for detecting an electric current value of the drive current of an actuator for driving the joint mechanism, and external force torque detection means for detecting level of torque from an external force supplied to the output access of the actuator based on the electric current value detected by an electric current protection unit. All of these components are contained within the joint mechanism itself, which thereby simplifies the configuration of the robot. In one embodiment of the joint control apparatus of the present invention, the joint control apparatus includes an actuator. The actuator includes an electric current detector for detecting a drive current of the actuator, a torque detector for detecting the amount of torque based on the drive current detected by the electric current detector and a controller for controlling the actuator based on the amount of torque detected by the torque detector. (Specification, page 3, lines 14-21). These components control the movement of the joint of the robot.

Similarly, in a robot device control method of the present invention, the method includes the steps of detecting an electric current value of the drive current of an actuator using electric current detector included in the actuator; detecting a level of torque created by an external force supplied to the output access of the actuator based on the detected electric current value using controller included in the actuator; and controlling the actuator using the controller included in the actuator such that the torque created by the external force supplied to the output access of the

actuator can be removed based on the detective result obtained in the second step. (Specification, page 4, lines 3-15).

By including the electric current detector, external force torque detector and controller in the joint apparatus itself, the need for complex wiring and sensors is eliminated. As a result, the joint apparatus method of the present invention largely reduces the number of wires between the actuator and the external devices such as a central processing unit and simplifies the overall configuration of the joint devices of the robot. (Specification, page 7, lines 1-11).

VI. ISSUE

Would the joint control apparatus and method as defined by Claims 1, 3, 4, 6, 8, 9 and 11-30 been obvious to one of ordinary skill in the art at the time the invention was made in view of *Onaga et al., Tsai et al.*, *Villaret* and *Takenaka*?

VII. GROUPING OF THE CLAIMS

Claims 1, 3, 4, 6, 8, 9 and 11-30 stand or fall together.

VIII. ARGUMENT

The Joint Control Apparatus and Method as Defined by Claims 1, 3, 4, 6, 8, 9 and 11-30 would not have been Obvious to One of Ordinary Skill in the Art at the Time the Invention was Made Over *Onaga et al.* in view of *Tsai et al., Villaret* and *Takenaka et al.*

Appellants respectfully submit that the rejection of Claims 1, 3, 4, 6, 8, 9 and 11-30 under 35 U.S.C. §103 should be reversed based on the fact that the Examiner has failed to establish a *prima facie* case of obviousness. To the extent that the references are even combinable, the Examiner has failed to establish that the cited references, alone or in any combination, teach

and/or suggest each and every feature of the claimed invention as required by Claims 1, 3, 4, 6, 8, 9 and 11-30.

1. **The Applicable Law**

The Federal Circuit has held that the legal determination of an obviousness rejection under 35 U.S.C. §103 is:

> whether the claimed invention as a whole would have been obvious to a person of ordinary skill in the art at the time the invention was made...The foundational facts for the prima facie case of obviousness are: (1) the scope and content of the prior art; (2) the difference between the prior art and the claimed invention; and (3) the level of ordinary skill in the art...Moreover, objective indicia such as commercial success and long felt need are relevant to the determination of obviousness...Thus, each obviousness determination rests on its own facts.
>
> *In re Mayne*, 41 U.S.P.Q.2d 1451, 1453 (Fed. Cir. 1997).

In making this determination, the Examiner has the initial burden of proving a *prima facie* case of obviousness. *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). This burden may only be overcome "by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings." *In re Fine*, 837 F.2d 1071, 1074, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988).

To establish obviousness based on a combination of elements in the prior art, there must be some motivation, suggestion or teaching of the "desirability" of making the specific combination that was made by the applicant. *In re Werner Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313, 1316 (Fed. Cir. 2000). The Examiner must show the "reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art" and combine those elements in the

same manner as the claimed invention. *See In re Rouffet*, 149 F.3d at 1357, 47 U.S.P.Q.2d at 1458. This Court has identified three possible sources for determining whether a motivation to combine references exists: (1) the nature of the problem to be solved, (2) the teachings of the prior art, and (3) the knowledge of persons of ordinary skill in the art. *Id.* If there is no motivation to combine the cited references then the obviousness rejection is improper.

Further, the Federal Circuit has held that "obvious to try" is not the standard under 35 U.S.C. §103. *Ex parte Goldgaber*, 41 U.S.P.Q.2d 1172, 1177 (Fed. Cir. 1996). "An-obvious–to–try situation exists when a general disclosure may pique the scientist curiosity, such that further investigation might be done as a result of the disclosure, but the disclosure itself does not contain a sufficient teaching of how to obtain the desired result, or that the claim result would be obtained if certain directions were pursued." *In re Eli Lilly and Co.*, 14 U.S.P.Q.2d 1741, 1743 (Fed. Cir. 1990).

"If the examination at the initial stage does not produce a prima facie case of unpatentability, then without more the applicant is entitled to grant of the patent." *In re Oetiker*, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992).

2. There is no Teaching or Suggestion within the *Onaga et al*,. *Tsai et al*, *Villaret* and *Takenaka et al.* References, nor within the General Knowledge of those Skilled in the Art that would have Motivated One Skilled in the Art to Combine the Teaching of *Onaga et al.* with that of *Tsai et al*, *Villaret* and *Takenaka et al.* to Arrive at the Claimed Invention.

In order to combine references under 35 U.S.C. §103 there must be some teaching or suggestion within the references themselves or with the general knowledge available to those of ordinary skill in the art which would lead one skilled in the art to combine the teaching of the references in question. In the present case there is no such teaching or suggestion which would

have led a skilled artisan to combine the teaching of *Onaga et al.* with that of *Tsai et al., Villaret*, and *Takenaka et al.* to arrive at the invention claimed in the instant application.

Onaga et al. teach a backup velocity monitor and protection system in a robot control system. In robots, the controls for controlling robot joints are typically controlled with a velocity control loop configuration that includes a velocity control for each joint motor. The velocity control loop uses joint motor velocity feedback usually generated by a sensor such as a tachometer to control the movements of the joints. If the tachometer becomes defective or if the velocity feedback information signal is erroneous or lost, the control of the particular robot joint is essentially lost. The resultant arm motion due to the erroneous movement of the joint may lead to injury or damage of products or property.

Onaga et al. therefore teach a backup monitoring and protection system to identify defective or erroneous velocity feedback information and provide the appropriate protective action. The control system of *Onaga et al.* is a multi-axis digital robot control which utilizes a torque processor board 600, a servo control board 400 and an AIF board 800 to completely provide six access control for the robot joints. These boards thereby control all of the movements of the joints in the robot arm. The backup velocity monitoring system independently monitors and determines the velocity of each joint motor from the electric current, terminal voltage and the motor inductance and resistance controlled by the above boards. The monitoring means makes comparisons between the primary and backup velocity signals for each joint motor to identify any defective, erroneous or lost velocity feedback signals. If defective or erroneous velocity feedback signals are discovered, the backup mechanism provides the appropriate protective action. *Onaga et al.* is therefore concerned with providing a backup system that

identifies defective and/or erroneous velocity feedback information from one or more joint motors to minimize and/or prevent undesirable joint movements in a robot.

Tsai et al., on the other hand, discloses a system for controlling backlash in gear-coupled transmission mechanisms. The system uses redundant unidirectional drives to continuously assure positive coupling of meshing gears in multiple Degrees Of Freedom (DOF) transmission systems. Specifically, the system includes a closed loop controller including adaptive anti-backlash torque command means where the gears are always positively engaged in an operational state because the torque generated by the input drive devices of the gears is unidirectional. Thus, *Tsai et al* is concerned with preventing backlash in devices having multiple degrees of freedom such as gear-driven machines and the like.

As is evident from the teachings of *Onaga et al.* and *Tsai et al.*, the teaching of one is totally unrelated to the teaching of the other. One of ordinary skill in the art interested in developing a backup system to monitor the validity of a velocity feedback signal generated by servo-motors associated with robotic joints, would not have been motivated to employ the unidirectional torque method taught by *Tsai et al.* Furthermore, *Onaga et al.* do not teach or suggest that backlash is a problem in their joint mechanisms. Employing an anti-backlash drive system or similar system is irrelevant to the problem addressed by *Onaga et al.* Therefore, one of ordinary skill in the art would not have considered the *Tsai et al.* reference useful. In fact, neither reference is particularly relevant to solve the problem of reducing the amount of complex wiring in the joints to improve the durability and mobility of the robot devices as solved by the claimed invention.

The *Villaret* and *Takenaka* references were cited to further clarify components allegedly disclosed by the combination of *Onaga* and *Tsai*. Specifically, the Examiner states in the July

30, 2003 Office Action that *Villaret* discloses torque detectors, current detectors and an actuator or motor which are included in an "actuator case 31." However, the reference numeral 31 refers to servo controller 31 and reference numeral 37 refers to the actuator or motor (Col. 6, lines 15-24; Figs. 2-3). As shown in Fig. 2, the servo controller 31 is a separate and independent component from the motors 37. In fact as described in *Villaret*, the servo controller 31 receives an input from the encoder 36 and outputs current values to the motors 37 (Col. 6, lines 23-25). Specifically, the actual torques are outputted to the motors from the servo amplifier 51 and the position values are received from the encoder device 36 (which is <u>not</u> part of the motor 37) (Fig. 3; Col. 6 line 44 to Col. 7, line 9). Thus, the position and torque sensors and control devices are not located in the motor 37 or in the motor housing or case. As a result, *Villaret* does not teach or suggest including such elements in the motor to control the operation of the motor and minimize the wiring associated with a robot joint.

The Examiner states in the July 30, 2003 Office Action that "applicant argues that Villaret shows the servo controller containing the elements and not the motor or actuator itself. However, a servo controller or mechanism can be considered an actuator, wherein the servo comprises the motor and the elements cited above [are] used in controlling the motor . . ." Applicants respectfully disagree with the Examiner.

As described above, the servo controller and the motors are separate components. *Villaret* does not disclose, teach or suggest that the servo controller and the motors are a single unit or that these components are "provided together" as suggested by the Examiner. Additionally, whether the servo controller can be considered an actuator on a broader level is irrelevant. The use of the term servo controller does not mean that the servo controller is an actuator or even can be considered an actuator. When a claim term or terms are not "defined by

[the] applicant in the specification, the words of the claim must be given their plain meaning." *Rexnord Corp. v Laitram Corp.*, 60 U.S.P.Q.2d 1851, 1854 (Fed Cir. 2001); see also MPEP § 2111.01. In *Villaret*, the term "servo controller" as used in Claims 8 and 11, is clearly defined in the specification as an "electronic system that controls the movements of the arms, by controlling the current supplied to the actuators." (Col. 3, lines 53-55). In addition, Fig. 2 clearly shows the servo controller and the motors as separate and independent components. *Villaret* therefore does not disclose, teach or suggest that the servo controller is an actuator or can be considered an actuator.

Due to the lack of any teaching or suggestion in the references themselves or within the general knowledge of those skilled in the art to combine the two references, the Examiner has not met his burden of establishing that the rejected claims are *prima facie* obvious under 35 U.S.C. §103, and the final rejection of claims 1, 3, 4, 6, 8, 9 and 11-22 should be reversed.

3. Even if One of Ordinary Skill in the Art would have been Motivated to Combine *Onaga et al.* and *Tsai et al.* as Suggested by the Examiner, the Combination does not Teach or Suggest Every Element of the Claimed Invention as a Whole

The test for determining obviousness over a combination of references requires that the combined references must teach or suggest every element of the claimed invention.

In the present case each of the independent claims on appeal, claims 1, 4, 6, 9, 11, 13, 14, 16, 18, 19, 20, 22 23, 25, 27 and 29 calls for either a joint control apparatus, robot apparatus, robot device or robot device control method for controlling the movement of a robot joint including an actuator. Each actuator includes an electric current detector for detecting a drive current of the actuator; torque detector for detecting the amount of torque based on the drive

current detected by the electric current detector; and controller for controlling the actuator based on the amount of torque detected by the torque detector. Each of the electric current detectors, the torque detectors and the controllers are to be included in the actuator. This feature substantially reduces the amount of wiring in the joint and simplifies the overall joint design. Each of the method claims calls for, among other things, a method for controlling the movement of a robot joint including the steps of detecting the drive current of an actuator using an electric current detector included in the actuator; detecting an amount of torque based on the drive current detected by the electric current detector using torque detector included in the actuator; and controlling the actuator using controller based on the amount of detected torque.

According to the Examiner, *Onaga et al.* teach every element of the claims except for an actuator including a current detector, a torque detector, and controller. The Examiner relies on *Tsai et al.* to remedy this deficiency. The Examiner alleges that *Tsai et al.* includes actuators 2 and 3 having controller, current detectors and torque detectors. Applicants contend that *Tsai et al.* does not disclose an actuator including electric current detectors, torque detectors and controller within the actuator itself as required by the rejected claims. Therefore, Applicants respectfully submit that the combination of *Onaga et al.* and *Tsai et al.* does not teach or suggest all of the elements of the claimed invention.

As discussed above, *Onaga et al.* is directed a multi-axis digital robot control which employs a torque processor board 600, a servo control board 400 and an AIF board 800 to completely provide six access control for the robot joints. As shown in Fig. 4 of *Onaga et al.*, the boards 400, 600, and 800 are all external to the robot 20. Therefore the control boards are not located within the actuators associated with the robot joints as in the claimed invention. Because the actuators are controlled externally, and not within the actuators themselves, substantial

wiring is required to connect the boards to the actuators in robot joints. As a result, the control method used in *Onaga et al.* provide a complex control system which involves complex wiring and circuits to and from boards 400, 600 and 800 to the joints. This increases the likelihood that the wiring will tear or break during rotation of the joints and also makes the robot unit itself much heavier, less mobile and cumbersome.

Turning to *Tsai et al.*, the Examiner cites *Tsai et al.* for teaching an actuator that includes a current detector, a torque detector and controller. The teaching in *Tsai et al.* is cited to remedy the lack of an explicit teaching by *Onaga et al.* of such an actuator. The Examiner specifically references Figure 3 of *Tsai et al.* as showing this feature. Figure 3 discloses actuators 2 and 3 which drive the joints or links respectively. The actuators are motors "whose torque is controlled by either a computer, a PD controller or a PID controller." See Col. 9, lines 5-11. In particular, the controllers, or computer, use sensors to detect the position and velocity of the joints and then process control signals that are sent to the actuators. Therefore, the control devices in *Tsai et al.* are <u>not</u> located in the actuators themselves, but are separate units located at some other portion of the robot arm or unit. In fact, *Tsai et al.* discloses the actual controller configuration in Figure 10, which shows that the torque command or control is external from the robot system. Thus, *Tsai et al.* does not teach or suggest actuators for moving robot joints which include electric current detectors, torque detectors and controllers within the actuators themselves as in the claimed invention.

As discussed above, *Villaret* does not teach or suggest including the position and torque sensors and control devices to be located in the motor or in the motor housing or case to control the operation of the motor and minimize the wiring associated with a robot joint. The *Villaret* reference teaches that the servo controller 31 and the actuator or motor 37 are separate and

independent components (Fig. 2; Col. 6, lines 15-24; Figs. 2-3). In fact as described in *Villaret*, the servo controller 31 receives an input from the encoder 36 and outputs current values to the motors 37 (Col. 6, lines 23-25). Specifically, the actual torques are outputted to the motors from the servo amplifier 51 and the position values are received from the encoder device 36 (which is <u>not</u> part of the motor 37) (Fig. 3; Col. 6 line 44 to Col. 7, line 9).

As described above, the servo controller and the motors are separate components. *Villaret* does not disclose, teach or suggest that the servo controller and the motors are a single unit or that these components are "provided together" as suggested by the Examiner. Additionally, whether the servo controller can be considered an actuator on a broader level is irrelevant. The use of the term servo controller does not mean that the servo controller is an actuator or even can be considered an actuator. When a claim term or terms are not "defined by [the] applicant in the specification, the words of the claim must be given their plain meaning." *Rexnord* 60 U.S.P.Q.2d at 1854; see also MPEP § 2111.01. In *Villaret*, the term "servo controller" as used in Claims 8 and 11, is clearly defined in the specification as an "electronic system that controls the movements of the arms, by controlling the current supplied to the actuators." (Col. 3, lines 53-55). In addition, Fig. 2 clearly shows the servo controller and the motors as separate and independent components. *Villaret* therefore does not disclose, teach or suggest that the servo controller is an actuator or can be considered an actuator.

Thus, even if one of ordinary skill in the art would have been motivated to combine the teaching of *Onaga et al.* with that of *Tsai et al.*, *Villaret* and *Takenaka*, the combination nonetheless fails to teach or suggest at least a joint control apparatus including an electric current detector for detecting a drive current of the actuator; torque detector for detecting the amount of

torque based on the drive current detected by the electric current detector; and controller for controlling the actuator based on the amount of torque detected by the torque detector.

Because the *Onaga et al.*, *Tsai et al.*, *Villaret* and *Takenaka.* combination fails to teach or suggest every element of the claimed invention, the final rejection of claims 1, 3, 4, 6, 8, 9 and 11-30 is improper and should be reversed.

IX. CONCLUSION

Appellants respectfully submit that all of the pending claims are in condition for allowance over the art of record. The Examiner has failed to establish a *prima facie* case of obviousness under 35 U.S.C. § 103(a) with respect to Claims 1, 3, 4, 6, 8, 9 and 11-30. Therefore, Appellants respectfully submit that the rejections of pending Claims 1, 3, 4, 6, 8, 9 and 11-30 is an error in law and in fact and should be reversed by this Board.

Respectfully submitted,

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APPENDIX

1. A joint control apparatus for controlling the movement of a robot joint, which includes a first link and a second link where the first link is rotated about a predetermined axis with torque generated by the apparatus, said apparatus comprising:

an actuator;

electric current detection means included in said actuator for detecting a drive current of the actuator;

torque detection means included in said actuator for detecting the amount of torque based on the drive current detected by said electric detection means; and

control means included in said actuator for controlling the actuator based on the amount of torque detected by said torque detection means.

3. The joint control apparatus according to Claim 1, wherein the actuator includes:

a motor unit that generates the torque depending on a supplied drive current;

a torque amplification unit that amplifies the torque generated by said motor unit, and transmits the torque to the actuator; and

motor control means included in said motor unit for controlling said motor unit by supplying said motor unit with a level of drive current based on externally provided control information.

4. A joint control method for controlling the movement of a robot joint in which the joint includes a first link and a second link where the first link is rotated about a predetermined axis with torque generated by the apparatus, said method including:

a first step of detecting a drive current of the actuator using an electric current detection means included in the actuator;

a second step of detecting an amount of torque based on the drive current detected by the electric current detection means using torque detection means included in the actuator; and

a third step of controlling the actuator using control means based on the amount of torque detected in said second step.

6. A robot device including a joint control apparatus for controlling the movement of the joint, which includes a first link and a second link where the first link is rotated about a predetermined axis with torque generated by the apparatus, said apparatus comprising:

an actuator;

electric current detection means included in said actuator for detecting a drive current of the actuator;

torque detection means included in said actuator for detecting the amount of torque based on the drive current detected by said electric current detection means; and

control means included in said actuator for controlling the actuator based on the amount of torque detected by said torque detection means.

8. The robot device according to Claim 6, wherein the actuator includes:

a motor unit that generates the torque depending on a supplied drive current;

a torque amplification unit that amplifies the torque generated by said motor unit, and transmits the torque to the actuator; and

motor control means included in said motor unit for controlling said motor unit by supplying said motor unit with a level of drive current based on externally provided control information.

9. A robot device control method having a joint mechanism for controlling the movement of a the joint, which includes a first component and a second component where the first component is rotated about a predetermined axis with torque that is output from the actuator through an output axis of the actuator, comprising:

a first step of detecting an electric current value of the drive current of the actuator using electric current detection means included in the actuator;

a second step of detecting a level of a torque created by an external force applied to the output axis of the actuator based on the detected electric current value using control means included in said actuator; and

a third step of controlling the actuator using control means included in said actuator such that the torque created by the external force applied to the output axis of the actuator can be removed based on a detected result obtained in said second step.

11. A robot device having a pair of leg units in each of which a lower leg unit is connected to a thigh unit through a knee joint mechanism, and a foot unit connected to the lower leg unit through an ankle joint mechanism, said pair of leg units being driven in a predetermined pattern such that a walking operation is performed wherein said foot units of said leg units alternately touch a walking path on which the robot device is placed said robot device comprising :

an actuator, provided in said ankle joint mechanism, generating a rotation torque whose level depends on a drive current for rotation-driving said foot unit on a predetermined axis;

electric current detection means included in said actuator for detecting an electric current value of the drive current of the actuator;

torque detection means included in said actuator for detecting a level of torque created by an external force applied to the output axis of the actuator based on the electric current value detected by said electric current detection means; and

control means included in said actuator for controlling the actuator based on a detection result from said torque detection means such that the external force applied to the output axis of the actuator can be removed.

12. The robot device according to Claim 11, said actuator comprising:

a motor unit generating the rotation torque depending on a supplied drive current;

a torque amplification unit amplifying the rotation torque generated by said motor unit, and transmitting the torque to said output axis; and

motor control means included in said motor unit for controlling said motor unit by supplying said motor unit with the drive current at a level according to externally provided control information.

13. A method of controlling a robot device having a pair of leg units in which a lower leg unit is connected to a thigh unit through a knee joint mechanism, and a foot unit is connected to the lower leg unit through an ankle joint mechanism, said pair of leg units being driven in a predetermined pattern such that a walking operation is performed wherein said foot units of said leg units alternately touch a walking path one which the robot device is placed, said method comprising:

a first step of detecting an electric current value of the drive current using electric current detection means included in an actuator in said ankle joint mechanism, and generating a rotation torque whose level depends on a drive current for rotation-driving said foot unit on a predetermined axis;

a second step of detecting an externally applied torque using external torque detection means included in said actuator, where said external torque is determined by creating an external force applied to the output axis of the actuator based on the detected electric current value; and

a third step of controlling the actuator using control means included in said actuator, based on a detection result obtained in said second step, such that the external force applied to the output axis of the actuator can be counteracted.

14. A joint device in which a first link connected to a second link is freely rotatable about a predetermined axis, the joint device comprising

an actuator generating rotation torque for rotation-driving said first link about said predetermined axis,

said actuator comprises:

a motor unit generating the rotation torque; and

motor control means included in said motor unit for controlling the rotation torque output from said motor unit.

15. The joint device according to Claim 14, further comprising:

torque amplification means for amplifying the rotation torque output from said motor unit, characterized in that

said motor unit and said torque amplification means are incorporated into one unit.

16. A robot device having a joint mechanism in which a first component is connected to a second component in a freely rotating manner about on a predetermined axis, and

an actuator generating a rotation torque for rotation-driving said first component about the predetermined axis, said actuator comprising:

a motor unit generating the rotation torque; and

motor control means included in said motor unit for controlling the rotation torque output from said motor unit.

17. The robot device according to Claim 16, further comprising

a torque amplification means for amplifying the rotation torque output from said motor unit, characterized in that

said motor unit and said torque amplification means are incorporated into one unit.

18. A control apparatus for controlling a joint mechanism comprising:

a first link;

a second link connected to said first link being capable of rotating around a predetermined axis;

a motor for rotating said first link around said predetermined axis on the basis of a rotation torque output through an output axis of the motor; and

control means for controlling said joint mechanism;

wherein

said motor has a motor case that includes a rotation axis, drive means for driving said rotation axis, electric current detection means for detecting an electric current value of the drive current of the motor, and external force torque detection means for detecting a torque applied to the output axis of the motor based on the electric current value detected by the electric current detection means in said motor case, and wherein

said control means controls said joint mechanism based on said external force torque detected by said external force torque detection means.

19. A robot apparatus including a joint mechanism comprising:

a first link;

a second link connected to said first link being capable of rotating around a predetermined axis;

a motor for rotating said first link around said predetermined axis on the basis of a rotation torque output through an output axis of the motor; and

control means for controlling said joint mechanism;

wherein

said motor has a motor case that includes a rotation axis, drive means for driving said rotation axis, electric current detection means for detecting an electric current value of the drive current of the motor, and external force torque detection means for detecting a torque applied to the output axis of the motor based on the electric current value detected by the electric current detection means in said motor case, and wherein

said control means controls said joint mechanism based on said external force torque detected by said external force torque detection means.

20. A robot apparatus having a plurality of joint mechanisms driven by an actuator comprising:

a memory for storing a plurality of values of self weight (tare) torque which are applied to each joint at the time of each posture;

means for calculating an output torque which drives each of said joints;

means for calculating an external force torque applied to said joint by subtracting said self-weight (tare) torque from said output torque; and

control means for controlling said joint mechanism according to said external force torque.

21. The robot apparatus of Claim 20, wherein said actuator includes:

electric current detection means for detecting an electric current value of the drive current of the actuator; and

external force torque detection means for detecting a level of torque by an external force applied to the output axis of the actuator based on the electric current value detected by said electric current detection means.

22. A robot apparatus including a joint mechanism comprising:

a first link;

a second link connected to said first link being capable of rotating around a predeterminated axis;

a motor for rotating said first link around said predetermined axis on the basis of a rotation torque output through an output axis of the motor; and

control means for controlling said joint mechanism; and wherein:

said motor has a motor case that includes servo control means for controlling the motor rotation by a servo system; and

said control means controls said joint mechanism based on said servo control by said serve control means.

23. A robot apparatus having a joint unit, comprising:

a joint control unit for controlling the joint unit; and

a motor unit provided in said joint unit and including motor control means, electric current detection means for detecting an electric current value of a motor drive electric current, and operation processing means, wherein:

said operation processing means, which is inside said motor unit, calculates an external force torque generated at said joint unit based on said electric current value; and

said joint control means controls said motor control means so as to reduce said external force torque.

24. The robot apparatus according to claim 23, wherein the robot apparatus is a legged walking robot and said joint unit is an ankle joint unit.

25. A control method for a robot apparatus having a joint unit and a motor unit for driving said joint unit, comprising:

a first step at which, inside said motor unit including motor control means, electric current detection means for detecting an electric current value of a motor drive electric current, and operation processing means, said operation processing means calculates an external force torque generated at said joint unit based on said electric current value; and

a second step at which joint control means provided outside said motor unit controls said motor control means so as to reduce said external force torque.

26. The control method for a robot apparatus according to claim 25, wherein the robot apparatus is a legged walking robot and said joint unit is an ankle joint unit.

27. A robot apparatus having a joint unit, comprising:

a motor unit provided in said joint unit, and including motor control means, electric current detection means for detecting an electric current value of a motor drive electric current, and operation processing means, wherein:

said operation processing means, inside said motor unit, calculates an external force torque generated at said joint unit based on said electric current value and said motor control means controls said motor unit so as to reduce said external force torque.

28. The robot apparatus according to claim 27, wherein the robot apparatus is a legged walking robot and said joint unit is an ankle joint unit.

29. A control method for a robot apparatus having a joint unit and a motor unit for driving said joint unit, comprising:

a first step at which, inside said motor unit including motor control means, electric current detection means for detecting and electric current value of a motor drive electric current, and operation processing means, said operation processing means calculates an external force torque generated at said joint unit based on said electric current value; and

a second step at which said motor control means controls said motor unit so as to reduce said external force torque calculated.

30. The control method for a robot apparatus according to claim 29, wherein said robot apparatus is a legged walking robot and said joint unit is a joint unit of an ankle.

SUPPLEMENTAL APPENDIX

Exhibit A: Final Office Action (Mailed on July 30, 2003)

Exhibit B: U.S. Patent No. 4,807,153 (*Onaga et al.*)

Exhibit C: U.S. Patent No. 5,245,263 (*Tsai et al.*)

Exhibit D: U.S. Patent No. 6,222,338 (*Villaret.*)

Exhibit E: U.S. Patent No. 6,064,167 (*Takenaka*)

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/646,849	10/17/2000	Tatsuzo Ishida	TNAB-T0158	1114

29175 7590 07/30/2003

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EXAMINER	
FLETCHER, MARLON T	
ART UNIT	**PAPER NUMBER**
2837	

DATE MAILED: 07/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

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ATTY: WEV/JHC
DOCKET #: 113298-002

Office Action Summary	Application No. 09/646,849	Applicant(s) ISHIDA ET AL.
	Examiner Marlon T Fletcher	Art Unit 2837

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 19 May 2003.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1,3,4,6,8,9 and 11-30 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1,3,4,6,8,9 and 11-30 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1, 3, 4, 6, 8, 9, 11-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Onaga et al. (4,807,153) in view of Tsai et al. (5,245,263), Villaret (6,222,338) and Takenaka et al. (6,064,167).

As recited in claims 1, 4, 6, 9, and 23-30, Onaga et al. disclose a robot device and

control method including a joint mechanism control apparatus and method as seen in figures 1 and 2 and as discussed in column 5, lines 5-8, having an actuator for generating a rotation torque whose level depends on a drive current, connecting a first link to a second link as freely rotating on an predetermined axis, and rotating the first link on the predetermined axis based on the rotation torque output from the actuator through an output axis of the actuator as discussed in column 4, lines 36-45, characterized by comprising: electric current detection means for detecting an electric current value of the drive current of the actuator as discussed in column 6, lines 5-18, lines 48-57, column 7, lines 60-64, column 16, lines 31-34, and column 18, lines 47-62; and external force torque detection means for detecting a level of a torque by an external force applied to the output axis of the actuator based on the electric current

value detected by said electric current detection means as discussed in column 6, lines 5-18, column 6, line 58 through column 7, line 2, column 15, line 30 through column 16, line 30, and column 18, lines 47-62.

Onaga et al. disclose the robot device and method including the joint mechanism control apparatus and method, characterized by further comprising: control means for controlling the actuator based on a detection result from said external force torque detection unit such that the external force applied to the output axis of the actuator can be removed as discussed in column 6, line 58 through column 7, line 2, column 15, lines 32-54, and column 16, lines 7-30.

As recited in claims 3, 8, and 14-17, Onaga et al. disclose the robot device and method including the joint mechanism control apparatus and method, characterized in that: said actuator comprises: a motor unit generating the rotation torque depending on a supplied drive current as discussed in column 6, lines 5-15; a torque amplification unit (174, 150) amplifying the rotation torque generated by said motor unit, and transmits the torque to said output axis as discussed in column 6, lines 8-15 and lines 58-65; and motor control means for controlling said motor unit by supplying said motor unit with the drive current at a level according to externally provided control information, and said motor control unit is provided in said motor unit as discussed in column 6, lines 11-15 and lines 48-57, column 8, lines 11-14, and column 15, lines 32-45.

As recited in claims 11, 13, and 18-30, Onaga et al. disclose a robot device and method having characterized by comprising: an actuator, provided in a joint mechanism, generating a rotation torque whose level depends on a drive current for rotation-driving

said arm unit on a predetermined axis; electric current detection means for detecting an electric current value of the drive current of the actuator as discussed in column 6, lines 5-18, lines 48-57, column 7, lines 60-64, column 16, lines 31-34, and column 18, lines 47-62; and external force torque detection means for detecting a level of a torque by an external force applied to the output axis of the actuator based on the electric current value detected by said electric current detection means as discussed in column 6, lines 5-18, column 6, line 58 through column 7, line 2, column 15, line 30 through column 16, line 30, and column 18, lines 47-62; and control means for controlling the actuator based on a detection result from said external force torque detection unit such that the external force applied to the output axis of the actuator can be removed as discussed in column 6, line 58 through column 7, line 2, column 15, lines 32-54, and column 16, lines 7-30.

As recited in claim 12, Onaga et al. disclose the robot device, characterized in that: said actuator comprises: a motor unit generating the rotation torque depending on a supplied drive current as discussed in column 6, lines 5-15; a torque amplification unit (174, 150) amplifying the rotation torque generated by said motor unit, and transmits the torque to said output axis an as discussed in column 6, lines 8-15 and lines 58-65; and motor control means for controlling said motor unit by supplying said motor unit with the drive current at a level according to externally provided control information, and said motor control means is provided in said motor unit as discussed in column 6, lines 11-15 and lines 48-57, column 8, lines 11-14, and column 15, lines 32-45.

Onaga et al. do not teach the actuator including a current detector, a torque detector, and control means. Onaga et al. further do not disclose a pair of leg units in each of which a lower leg unit is connected to a thigh unit through a knee joint mechanism, and a foot unit is connected to the lower leg unit through an ankle joint mechanism.

However, Tsai et al. disclose an actuator (2 and 3) including control means as well as current (inherent) and torque detectors as discussed in column 9, lines 3-19 and as seen in figure 3.

Villaret is provided to more clearly show the use of torque detectors and current detectors, along with the motor, all included in an actuator case (31), wherein the actuator (31) is the controller as seen in figure 3, wherein the actuator can be used in conjunction with a robot as discussed in column 1, lines 13-17 and column 6, lines 17-24.

Takenaka et al. are provided to show the well known elements in the art, that robots comprise leg units which include a lower leg, a knee joint mechanism, a foot, and an ankle.

It would have been obvious to one of ordinary skill art at the time of the invention to utilize the teachings of Tsai et al., Villaret, and Takenaka et al. with the apparatus of Onaga et al., because Tsai et al., Villaret, and Takenaka et al., enhance the apparatus of Onaga et al. by providing the operating joint or motor with controller for controlling that joint, wherein current and torque is detected to provide control by the actuators to the joints, which inherently reduces wiring. In combination, it is believed that every

element recited in the claims are met by the references. All of the references are related to the robot art and therefore, can be combined.

Response to Arguments

3. Applicant's arguments filed 05/19/2003 have been fully considered but they are not persuasive.

It is believed that the above rejection, provides the teachings of the present invention, wherein Onaga et al. provide all of the elements claimed, but fails to provide the elements all included in the actuator or actuator case. Tsai et al. provide the actuator including the controller and the motor, wherein torque is detected, which inherently provides a detection of current. However, Villaret is provided to show that the torque sensor, as well as the current sensor, can be provided in the actuator or actuator case for providing control of the actuator. In use in the robot art, the combination would provide less wiring. Tsai et al. show a reduction of wiring in figure 3, wherein the controller and motor are provided together. The applicant argues that Villaret shows the servo controller containing the elements and not the motor or actuator. However, a servo controller or mechanism can be considered an actuator, wherein the servo comprises the motor and the elements cited above used in controlling the motor, wherein all of the elements are in one case or part (31) as seen in figure 3. Regardless of the view, this method reduces wiring.

4. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Marlon T Fletcher whose telephone number is 703-308-0848. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Nappi can be reached on 703-308-3370. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Marlon T Fletcher
Primary Examiner
Art Unit 2837

MTF
July 27,2003

AF/2837

TRANSMITTAL OF APPEAL BRIEF (Large Entity)	Docket No. 113298-002

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In Re Application Of: **Tatsuzo Ishida et al.**

Serial No.	Filing Date	Examiner	Group Art Unit
09/646,849	**10/17/2000**	**Marlon T. Fletcher**	**2837**

Invention: **APPARATUS AND METHOD FOR JOINT MECHANISM, JOINT APPARATUS, AND ROBOT DEVICE AND CONTROL METHOD THEREOF**

TO THE COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on

The fee for filing this Appeal Brief is: **$330.00**

☒ A check in the amount of the fee is enclosed.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818**

Signature

Dated: **June 2, 2004**

Jeffrey H. Canfield (Reg. No. 38,404)
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I certify that this document and fee is being deposited on 6/2/04 with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Karin Barrett

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Karin Barrett

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